State of California
AIR RESOURCES BOARD

Research Screening Committee Meeting
Cal/EPA Headquarters Building
1001 I Street
Conference Room 510
Sacramento, California 95814
(916) 445-0753

May 17, 2013
9:00 a.m.

ADVANCE AGENDA

I. Approval of Minutes of Previous Meeting:

March 8, 2013 meeting

II. Discussion of Draft Final Reports:

1) "Study of In-Use Emissions from Diesel Off-Road Equipment," University of California, Riverside, $300,000, Contract No. 08-315

Off-road diesel engines are a significant contributors to the California nitrogen oxides (NO_X) and particulate matter (PM) emissions inventories, but are not very well-characterized emissions sources because only the engine is certified, and until recently in-use emissions testing was problematic. Using their recently Environmental Protection Agency (EPA) approved portable emissions measurement system (PEMS), researchers from the University of California, Riverside, collected in-use emissions and engine parameter data from a fleet of 27 units of in-use construction equipment using the PEMS located on-board the emissions source being tested in the field. NO_X and PM emissions generally appear to be below the applicable emissions standards, although comparisons are complicated by the differences in engine operation between the steady-state certification test cycle, and actual in-use, transient engine operation. These new data are expected to be included in future updates of ARB's off-road emissions inventories. The improved emissions inventories for off-road sources will assist ARB policymakers and stakeholders in assessing the emissions contributions from these important sources.

2) "Integrated Physical and Chemical Measurements of Heavy-Duty Diesel Emissions at WVU Full Scale Wind Tunnel," University of California, Davis, $419,914, Contract No. 08-322

Understanding the health impact of mobile source diesel particles is challenging due to the complex physical and chemical evolution of the particles in the engine combustion, exhaust aftertreatment devices, and atmospheric plume-processing, especially near

roadways. The linkage between the particle emissions measured in the laboratory and near roadways is lacking. The research objective of the project was to characterize the physical and chemical evolution of diesel particulate matter emissions measured in a full-scale wind tunnel imitating real-world, near-road environmental conditions. Particulate matter, gaseous pollutant concentrations, and meteorological parameters were measured by multiple real-time instruments on cross-section sampling planes at various distances downwind of the exhaust at test speeds of 5, 20, and 35 mph. At the low test speed, the exhaust plume had high residence time, low turbulent mixing, and narrow dimension. At the high test speeds, the exhaust plume initially stretched longitudinally, but later expanded vertically due to the high turbulent mixing. Particles measured from the pre-2007 truck showed consistent changes in particle size distribution at test speeds of 20 and 35 mph as follows. Nucleation mode particles initially grew in size, and their concentration increased, and then shrunk in size, and their concentration decreased in the wind tunnel. The post-2007 vehicle emitted unusually high accumulation mode particle concentrations due to a crack in the diesel particulate filter (DPF) and a DPF regeneration event. Particles measured from the post-2010 trucks were significantly lower than the other two trucks, and in fact were comparable to the background particle concentrations. This study presents various particle evolution patterns from the three trucks, and further extensive data analysis work should follow to investigate several unexplained unique particle behaviors in the tunnel that may be related to the crack in the DPF, uncertainties in the aerosol instruments, and others.

3) "Improved Characterization of Primary and Secondary Carbonaceous Particles," University of California, San Diego, $255,000, Contract No. 09-328

Many urban and rural areas are out of compliance with California and federal ambient air quality standards for fine particulate matter (PM2.5). While advances have been made in measuring and modeling the inorganic ionic species that are found in particulate matter, much less is known about the organic fraction. Yet organic matter can be a major constituent of aerosols. Better understanding and characterization of organic aerosols through improved measurements are needed in order to identify their emission sources and impacts on health, visibility, and climate. This research included measurements of organic mass (OM) concentration by Aerosol Mass Spectroscopy (AMS) and Fourier Transform Infrared spectroscopy (FTIR), as well as X-ray Fluorescence (XRF) for elemental tracers. The results indicate that vehicle emissions are the main source of the OM portion of particulate matter. OM accounted for 56 percent of submicron particle mass (PM1) in summer at Bakersfield, California, with secondary organic aerosols (SOA) components contributing 80 percent to 90 percent of OM from May 15 to June 29, 2010. SOA formed from alkane and aromatic compounds, the two major classes of vehicle-emitted hydrocarbons, accounted for 65 percent of OM (72 percent SOA) in the summertime San Joaquin Valley (SJV). This research project supports ARB's strategy of reducing vehicular emissions which are the main source of OM.

lll. Discussion of New Research Projects:

1) "Examining Factors that Influence ZEV Sales in California," University of California, Los Angeles, $295,377, Proposal No. 2758-276

Consumer response to near- or pure zero-emission vehicle (ZEV) offerings and incentives in the future as the market continues to evolve and expand will be important to understand for achieving long-term climate and air quality goals. The objective of this research is to understand the emerging ZEV market in California by merging monthly ZEV registration data with census tract-level data and using econometric methods to correlate spatial and temporal factors with vehicle sales. This research would complement existing efforts by providing a more holistic perspective of the entire consumer base and also allow for more explicit evaluation of trends in the market relative to policy and market factors. The results of this study will be used to describe the current ZEV market and to refine future estimates of ZEV market potential in California for expected compliance with the Advanced Clean Cars program.

2) "The Future of Drop-In Fuels: Life-Cycle Cost and Environmental Impacts of Bio-Based Hydrocarbon Fuel Pathways," University of California, Berkeley, $400,000, Proposal No. 2759-276

Drop-in fuels are cleaner alternatives to fossil-derived gasoline and diesel fuels that would require the least modification to the existing infrastructure and vehicle fleet. Similar to other biofuels, drop-in fuels have the potential to reduce greenhouse gas emissions and are superior to petroleum-based fuels in terms of their impacts on air quality when combusted. In order to be commercially viable, the fuels need to be available in sufficient quantities and at competitive prices. Drop-in fuels are currently in a research and development phase, with pilot- and demonstration-scale plants under construction, but further research on the feasibility and cost-effectiveness of producing these fuels is needed.

For this project, researchers will analyze the technology, feasibility, costs, and environmental impacts of drop-in fuels at both demonstration and commercial scales. The researchers will consider a variety of different production pathways, including conversion of alcohols or sugars to hydrocarbons, algal oils, upgrading syngas, and conversion of biomass to bio-oil. They will perform a geospatial analysis to estimate where fuel production facilities could be located in order to maximize production and minimize environmental impacts. And they will develop strategies to monitor and track supplies, costs, and progress of these technologies. The results of this project will help assess the potential for production and use of drop-in fuels for achieving California's climate goals.

3) "The Feasibility of Renewable Natural Gas as a Large-Scale, Low-Carbon Substitute," University of California, Davis, $330,934, Proposal No. 2760-276

Renewable natural gas is a promising near-term, low carbon-intensity transportation fuel for both light-duty and heavy-duty vehicle applications. The Low Carbon Fuel Standard regulation already incorporates a number of pathways for renewable natural gas production such as landfill gas, dairy digesters, and high solids anaerobic digesters. Widespread, large-scale production of renewable natural gas would help achieve California's greenhouse gas emission reduction objectives, but more research is needed to facilitate the market penetration of this fuel. This project will examine renewable natural gas production and distribution, particularly for transportation fuel use in California. The researchers will develop a map of current and potential production sites, and will examine the feasibility, costs, and environmental impacts of

large-scale production and use. They will evaluate optimization of facility locations in order to maximize production and minimize environmental impacts. The researchers will also identify potential barriers to expanded production, and strategies to overcome them. The results of this research will provide insights into the economic and environmental feasibility of large-scale production and use of renewable natural gas as a low-carbon transportation fuel in California.

4) "Collection of Activity Data from On-Road Heavy-Duty Diesel Vehicles," University of California, Riverside, $371,724, Proposal No. 2761-276

This proposal addresses the importance of collecting activity data from heavy-duty diesel trucks equipped with SCR aftertreatment systems. SCR reduces NO_X in the exhaust stream, but requires adequate temperatures, typically at least 200°C, for the reduction to take place. However, there will be times when this temperature requirement is not met, such as initial engine start and during low loads experienced when the engine is idling, or when the vehicle is moving slowly on flat terrain. It is thus critical to characterize heavy-duty diesel truck activity profiles including operation duty cycles, number of engine starts, and engine soak time distributions, by their vocation type. Because there are 68 different SCR-equipped engines sold in California, and 27 different medium heavy-duty and heavy heavy-duty truck categories in EMFAC2011, a strategic data collection plan is important for the limited funding resources. This proposal first identifies major truck vocation types that are most likely to contribute the most to the state's NO_X emission inventories, then instruments 80 trucks with GPS data loggers and 20 trucks with Electronic Control Units (ECU) + Global Positioning System (GPS) data loggers, and collects instantaneous truck activity data for at least one month and up to six months on each vehicle. The collected data will be used to develop truck activity profiles by their vocation type. The activity profiles will provide critical information for updating emission inventories, quantifying the frequency of good SCR function from trucks meeting the 2010 NO_X certification standard, and comparing the vocational duty cycles to the certification duty cycles.

5) "Air Quality Impacts of Low Vapor Pressure-Volatile Organic Compounds," University of California, Riverside, $405,338, Proposal No. 2757-276

Low vapor pressure-volatile organic compounds (LVP-VOCs) are ingredients used in some consumer product formulations to meet VOC limits because the ARB Consumer Products Regulations provide an exemption for LVP-VOCs. This exemption was intended to exclude compounds that do not readily participate in ozone formation. However, some recent laboratory testing indicates that certain LVP-VOCs may have previously unrecognized air quality impacts. In light of these findings, research to better understand the atmospheric emissions of LVP-VOCs from consumer products and their impacts on ozone and SOA formation is needed. This research project will investigate the ambient evaporation rates of LVP-VOCs--both as pure compounds and in formulated consumer products sold in California, and conduct environmental chamber studies on selected LVP-VOCs and products that contain them to explore ozone and secondary organic aerosol formation from these compounds. The results will improve estimates of the emission rates of LVP-VOCs and their impacts on air quality, and can be used to improve air quality models. The results will also be used as part of ARB's assessment as to whether the exemption for LVP-VOCs in the Consumer Products Regulations should be modified.

6) “Environmental Fate of Low Vapor Pressure – Volatile Organic Compounds from Consumer Products: A Modeling Approach,” University of California, Davis, $200,000, Proposal No. 2762-276

The top three reactivity-based total organic gas emission sources in California’s South Coast Air Basin are light-duty passenger cars, off-road equipment, and consumer products, indicating that VOC emissions from consumer products could be a significant contributor to ozone formation. Currently low vapor pressure –LVP-VOCs used in consumer products are exempted from VOC limits in ARB’s Consumer Product Regulations. Depending on the emission rate, portion remaining in the gas phase, and reactivity, LVP-VOCs could be another contributor to ozone formation. However, to evaluate the impacts of LVP-VOCs on air quality, more research is needed to better understand the emission and environmental fate of LVP-VOCs, including what portion of LVP-VOCs disposed down-the-drain will be emitted to air and what portion of LVP-VOCs emitted will be in the gas phase to form ozone. This research project will develop multimedia environmental modeling tools to determine the fraction of emitted LVP-VOCs in the gas phase that is available for ozone formation reactions. The results from this project can provide important information and modeling tools for ARB to determine whether the exemption for LVP-VOCs in the Consumer Products Regulations should continue as is or be modified.

7) “Co-Exposure to Particulate Matter and Ozone: Pulmonary C-Fiber and Platelet Activation in Decreased Heart Rate Variability,” University of California, Davis, $600,782, Proposal No. 2763-276

People are routinely exposed to ambient air that contains a complex mixture of air pollutants. PM2.5 and ozone (O_3) appear to be responsible for the majority of serious health effects related to air pollution exposure, although little is known about whether or not they have interactive or synergistic effects on health endpoints. Exposure to PM2.5 has been significantly associated with adverse cardiovascular effects in a number of studies, and recently published results have suggested that ozone exposure, well-known to induce respiratory effects, may also have cardiovascular effects. Although the biological pathways through which inhaled air pollution impacts cardiovascular function are unclear, research has suggested that pulmonary, vascular and neuronal mechanisms each contribute to increased cardiovascular morbidity and mortality related to air pollution exposure. Normal and spontaneously hypertensive (SH) rats with implanted telemetry units that record the electrocardiogram and breathing pattern will be exposed for six hours to filtered air, and PM2.5 and O_3, alone and in combination. At the end of exposure, animals will be euthanized and the following endpoints evaluated: platelet activation, persistence of platelet-monocyte aggregates, levels of serotonin and thromboxane A2 (TXA2) in blood from the left ventricle, endothelial activation in the terminal pulmonary arterioles and the coronary vasculature, diameter and wall thickness of the pulmonary arteries, heart and lung histopathology, presence of platelet aggregates in blood vessel walls, heart rate variability, assessment for cardiac arrhythmias, and immunocytochemical assessment of nerve fibers (C-fibers) activation in heart and lung tissues. The resulting data will help to elucidate the specific roles of platelets, the vascular endothelium, pulmonary C-fibers, and pulmonary vascular vasoconstriction in altering cardiovascular function. The results of this study will advance our understanding of the biological mechanisms

mediating the cardiovascular and pulmonary effects of multi-pollutant exposures, and how different mechanistic pathways converge to induce adverse health effects. This knowledge will contribute to development of health protective ambient air quality standards, and may also contribute to development of new efficient emissions reduction approaches that target more than one air pollutant simultaneously.

8) "Cardiovascular Effects of Multi-Pollutant Exposure: Mechanisms and Interactions," University of California, Irvine, $583,621, Proposal No. 2764-276

The general public is typically exposed to a complicated mixture of air pollutants, although little is known about whether or not any of the pollutants have interactive or synergistic effects on health endpoints. Many studies have reported a significant association between PM2.5 and adverse cardiovascular effects, and recent studies have suggested that O_3 exposure, well-known to induce respiratory effects, may also have cardiovascular effects. Recently there has been interest is exploring the health effects of multi-pollutant exposures, primarily with the goal of developing efficient emissions reduction approaches that target more than one pollutant at a time, and thus provide broader health benefits. Because PM2.5 and O_3 are associated with the largest proportion of adverse health effects relatable to air pollution exposure, initial efforts to investigate the health effects of concurrent exposures have targeted these two pollutants. This proposed study will investigate three hypotheses relating to multi-pollutant exposure and adverse cardiovascular health effects: 1) Concurrent exposure to concentrated ambient fine particles (CAPs) and O_3 will induce greater acceleration of atherosclerosis and reduction in heart rate variability (HRV) than will exposure to either CAPs alone or O_3 alone; 2) CAPs generated during periods of high ambient photochemical activity (i.e. summer) will accelerate atherosclerosis progression more than CAPs generated during periods of low ambient photochemical activity (i.e. winter); and 3) removal of organic constituents from PM2.5 using a thermal denuder will block the atherosclerotic effects of PM, while atherogenic effects related to O_3 will persist. The investigators will measure markers of inflammation, size of and lipid incorporation into arterial atherosclerotic plaques, serum lipids and low density lipoprotein associated cholesterol (LDL), oxidized LDL, and will monitor changes in heart function using implanted electrocardiographic transponders in mice genetically susceptible to developing atherosclerosis. The results of the study will provide insight into: 1) the relative importance of primary versus secondary PM; 2) the role of semi-volatile components of the PM2.5 fraction; and 3) the extent of interaction or synergy between PM2.5 and O_3 for development and progression of atherosclerosis. This knowledge will contribute to development of health protective ambient air quality standards, and may also contribute to development of new efficient emissions reduction approaches that target more than one air pollutant simultaneously.

9) "Developing a New Methodology for Analyzing Potential Displacement," University of California, Berkeley, $695,792, Proposal No. 2765-276

Senate Bill 375 (SB 375) requires Metropolitan Planning Organizations (MPOs) in California to develop a Sustainable Communities Strategy (SCS) as part of their federally mandated Regional Transportation Plan (RTP), to demonstrate how, largely through reduced travel demand and vehicle miles traveled, they will meet regional passenger vehicle greenhouse gas reduction targets set by ARB. As California regions pursue more compact, transit-oriented development (TOD) to meet these targets, there

is increasing concern that new transit investment and development may lead to displacement, preventing low-income communities from sharing in the benefits of this type of development. This project will examine the relationship between transit-oriented development, displacement, and travel behavior in California. Partnering with two MPOs, it will develop a set of tools that will examine the likely outcomes around TODs in planning processes. It will also analyze the impact of policies to minimize displacement.

10) "Effectiveness of Sound Wall-Vegetation Combination Barriers As Near-Roadway Pollutant Mitigation Strategies," University of California, Los Angeles, $516,139, Proposal No. 2766-276

Although California has made tremendous strides in reducing vehicular emissions, a large body of evidence indicates increased exposure to traffic-related pollutants near busy roadways remains a concern. As California pursues infill development near transit as a greenhouse gas reduction strategy, there may be significant implications for near-roadway exposure. Strategies to reduce this exposure are needed; however, a stronger understanding of the effectiveness of potential mitigation options, and in particular sound wall (barrier) and vegetation combinations, is required. This project proposes a multi-basin, California-specific study to characterize the effectiveness of sound and vegetative barriers in dispersing and removing traffic-related pollutants. The results will provide insights into the value and best practices for siting and design of sound walls, and vegetation in combination with sound walls, to reduce downwind pollution from busy roadways.

lV. Discussion of Responses to A Request for Proposals (RFP):

1) "Evaluating Technologies and Methods to Lower Nitrogen Oxide Emissions from Heavy Duty Vehicles," RFP No. 12-310, Proposal No. 2767-276